5.3.3 Damping

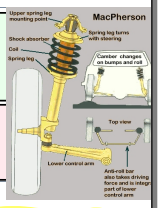
		Learning outcomes	Additional guidance
		Learners should be able to demonstrate and apply their knowledge and understanding of:	
2	(a)	free and forced oscillations	
	(b) (i)	the effects of damping on an oscillatory system	HSW9, 12
	(ii)	observe forced and damped oscillations for a range of systems	
	(c)	resonance; natural frequency	HSW9, 12
	(d)	amplitude-driving frequency graphs for forced oscillators	
	(e)	practical examples of forced oscillations and resonance.	HSW9, 12

(6) M - Define damping and describe examples
(7) S - Investigate a method of damping an oscillating mass
(8) C - explain the energy transformations for damped oscillations

Damping

STARTER: What are damped oscillations?

Extension: Can you think of any examples?



- **Damped oscillations** are ones where an external force acts on the oscillator to decrease the amplitude. Amplitude of oscillating mass decreases over time due to energy losses.

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Damping

Light damping - Amplitude decrease gradually over time, time period is almost unchanged. Damping force is small - Energy loss is small per oscillation.

Heavy damping - Amplitude decreases significantly over time. Damping force is large, time period increases slightly, energy losses are large per oscillation.

Very heavy damping - No oscillation - Mass moves back to equilibrium position slowly.

In all cases, KE transfers to heat and other forms of energy.

Sketch graph (1 min) while boards activity

Activity 1 : Read book pages. Complete the table below.

Sketch a graph of damping type to support your table

Damping example	Explian what makes it damping	Describe energy losses	Type of damping

Activity 2: Compare and contrast: free and forces oscillations. Giving examples.

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Damping

Demo: Hacksaw blade / card.

Show constant ratio property as a characteristic of some damping examples.

Summary questions

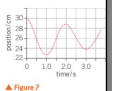
1 Give one example of a free oscillation and one of forced oscillation. *(2 marks)*

2 Describe how damping affects the amplitude of an oscillating object. *(1 mark)*

3 Sketch a graph of displacement against time for a simple pendulum with
a no damping
b a small amount of damping. *(4 marks)*

4 A data-logger is used to monitor the oscillations of a lightly damped oscillator. The results are shown in Figure 7.
a State why the amplitude decreases with time. *(1 mark)*
b State one quantity that remains constant for the oscillations. *(1 mark)*
c Determine the natural frequency of the oscillator. *(2 marks)*

5 The amplitude of a damped oscillator decreases exponentially with time. At time $t = 0$, the amplitude is 5.0 cm. The amplitude decreases to 90% after each period. The period of the oscillations is 1.0 s. Sketch the displacement–time graph for this damped oscillator up to a time of 5.0 s. *(4 marks)*



▲ Figure 7

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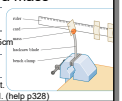
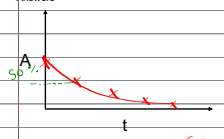
Damping

Investigate a method of damping a mass oscillating on a hacksaw blade



1. set up this apparatus with 0.1 kg mass and blade length 15cm
2. Displace 5 or 10cm and record the time period accurately.
3. Damp the oscillation - Explain why it is now damped
4. Plot a graph of positive amplitude against time.
5. What is the name of this relationship - what characterises it.
6. Use data to prove this is the type of relationship suggested. (help p328)
7. How much time is required to loose half the amplitude? What is significant about this time?
8. Compare the damped and undamped time period. What is the %age difference?
9. Describe the

Answers



- **Exponential relationship**. (decay)
- Amplitude decreases at a decreasing rate.
- Amplitude decreases by a fixed percentage in a given time
- Loss of energy is proportional to speed of the mass. As speed decreases so does energy loss.

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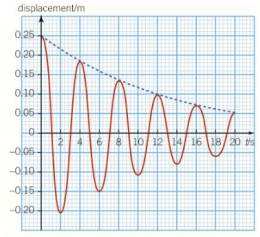
Plenary



▲ Figure 6 *Decay of the amplitude of a pendulum oscillating in air*

1 Determine the initial amplitude, the period, and the angular frequency of the pendulum in Figure 4.
2 Use the graph to determine if the amplitude decays exponentially.

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